Session 7: Linked Repositories – Theme of the Day

Moderator: Barbara Butler

Exploring Deep-sea Data

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Abstract
The Monterey Bay Aquarium Research Institute (MBARI) has collected and archived deep-sea video from remotely operated vehicle dives since 1988. The video archive contains footage and data on the biological, chemical, geological, and physical aspects of deep regions of the Pacific. MBARI developed a software system, the Video Annotation and Reference System, to create, store, and retrieve video annotations. The system is based on a hierarchical catalog of biological, geological, and technical terms that allows consistent and rapid classification of objects seen on video. Based on knowledge collected by the annotation process, MBARI staff developed a web-based Deep-Sea Guide to the organisms and geologic features recorded on remotely operated vehicle dives into the deep sea. The searchable guide provides information about biological taxonomy, geology, and habitats, and displays dynamic histograms and useful statistics derived from the video annotations.

Keywords: Deep-sea ecology, video description, ocean engineering, viewing underwater.

The Monterey Bay Aquarium Research Institute (MBARI) collected and archived over 24,000 hours of underwater video between 1988 and 2016. The research institute currently uses three remotely operated vehicles (ROVs) with a standard suite of instruments. The vehicles vary in size and depth range from the *Doc Ricketts*, the largest and most powerful of the three, with a depth rating of 4,000 meters, to midsized *Ventana* with a depth rating of 1,800 meters, to the small, 1,500 meter-rated *MiniROV* designed and built at MBARI as a portable system for use on ships of opportunity around the world. Each of the three vehicles carries a high-definition video camera as well as detachable, mission-specific toolsleds with sampling devices. Most of the ROV dives are recorded from the vehicle's launch to its recovery at the end of the mission.

The videotape archive contains television-quality and high-definition images of animals, geologic features of the seafloor, chemical experiments, and physical aspects of the Monterey submarine canyon and other deep regions of the Pacific. To make the images more useful for research and to improve general access, research technicians at MBARI annotate and archive the videos as an institutional resource (Connor 2005), in contrast to some institutions where image archives may be maintained by and accessible only to an individual scientist or laboratory group.

As the collection of video tapes and ancillary data increased over time, it became apparent that new technology was needed to streamline the process of describing video images and to relate those descriptions to ancillary chemical and physical data, and geolocation. The Video Annotation and Reference System (VARS) (http://www.mbari.org/vars/) was the result of a multiyear MBARI project to develop a software system for the efficient creation, storage, and retrieval of video annotations (Connor 2006). The foundation of the system is a knowledge database of over 4,000 biological, geological, and technical terms. This hierarchical index allows for the consistent classification, description, and complex querying of objects observed on video. The effort has proven fundamental to understanding how marine organisms and the results of ocean processes, such as the oxygen minimum zone, have changed over time, and how they may further evolve in the future.

As of November 2015, the VARS database held nearly five million annotations describing ROV dives. Taking advantage of MBARI video annotators' expertise and software engineering, the team recently completed development of a new tool called the Deep-Sea Guide (DSG), which aids in quality control, analysis, and interpretation of these valuable records. The DSG software application was written in Scala, a hybrid functional/object-oriented programming language, and hosted it on an application server (Schlining & Jacobsen Stout 2006).

This interactive, web-based system allows for the correlation and visualization of vast amounts of information. The system can be explored using either the Latin or common name of organisms to search or browse the VARS database used for video annotations. Taxonomic relationships are hyperlinked, so that clicking on a term in the ordered list (e.g., kingdom, phylum, family, genus) will open the relevant page with images and additional links to details on distributions, descriptive characteristics, and references for species and genera. Selections from over 350,000 annotated images are linked to the taxonomic terms providing rapid access to an extensive image collection of deep-sea organisms. Recognizing that no one source of information is complete, the pages automatically link terms in the DSG to the Encyclopedia of Life, the Tree of Life, the World Register of Marine Species (WoRMS) and the National Center for Biotechnology Information (NCBI) and provides a formatted citation.

Probing deeper into the DSG, a user can access standardized data products (e.g., raw or normalized depth distributions histograms of organisms or geologic features) for review and analysis. These tools can deliver quantitative and qualitative information for biodiversity assessment studies, and provide context for hypothesis generation and modeling of future studies. In these ways, the guide helps refine sampling and analysis methods, improve the effective exchange of information, and engage the research and education communities at large. MBARI researchers continually enrich the database content by adding images, concept

names, and descriptions as their knowledge grows. Updated entries and corrections to the DSG are published monthly.

MBARI typically embargoes annotations and related data for two years for internal quality control and analysis. Most of the observational data older than two years are available through the DSG (http://dsg.mbari.org) and the VARS public query system (http://www.mbari.org/vars/), but the data provided by a particular day's query are not necessarily representative of Monterey Bay or the entire VARS database. Although the data have proven to have great scientific value, the observations summarized in the DSG data products were not always collected using systematic research procedures, and biases have been introduced as a result of changing technical capabilities, mission objectives, and environmental conditions. In a continuing effort to refine sampling and analytic methods and to improve the effective exchange of information, deep-sea researchers are encouraged to contact MBARI to suggest improvements and explore potential collaborations.

References

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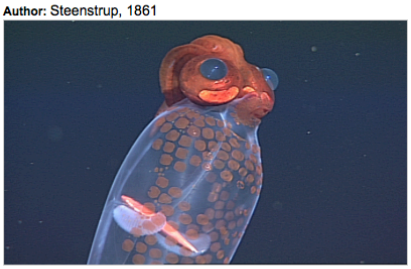
Taonius

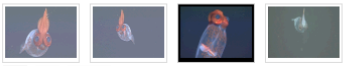
Author: Steenstrup, 1861



MBARI 2001: T263-04 Click here for a larger image.

Taxonomy:

- **Eukaryota** (superkingdom)
  - **Animalia** (kingdom)
    - **Mollusca** (phylum)
      - **Cephalopoda** (class)
        - **Coleoidea** (subclass)
          - **Decapodiformes** (superorder)
            - **Teuthoidea** (order)
              - **Oegopsida** (suborder)
                - **Cranchiidae** (family)
                  - **Taoniinae** (subfamily)
                    - ***Taonius*** (genus)
                      - ***Taonius borealis*** (species)
                      - ***Taonius pavo*** (species)



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Description

Size: Up to 660 mm mantle length.

General: Long, slender terminal fins and hook-like teeth on largest club suckers.

Geographic Information

Ocean range (global): Cosmopolitan.

Additional Information

References

Encyclopedia of Life

Tree of Life

World Register of Marine Species

National Center for Biotechnology Information

Media

Phylogenetic Image Gallery

Data Products

Annotated Images

Citation: *Taonius* (Steenstrup, 1861) Deep-Sea Guide (DSG) at http://dsg/mbari.org/dsg/view/concept/Taonius. Monterey Bay Aquarium Research Institute (MBARI). Consulted on 2015-10-29.